APPENDIX A

A1 - Sample Hardness Calculation of GW-T:

Hardness, as CaCO3($\frac{mg}{L}$)= 2.497 [Ca, $\frac{mg}{L}$]+ 4.118 [Mg, $\frac{mg}{L}$]

Hardness, as CaCO3($\frac{mg}{L}$)= 2.497 [18.11]+ 4.15 [4.15]

Hardness, as CaCO3($\frac{mg}{L}$)= 61.9 mg/L

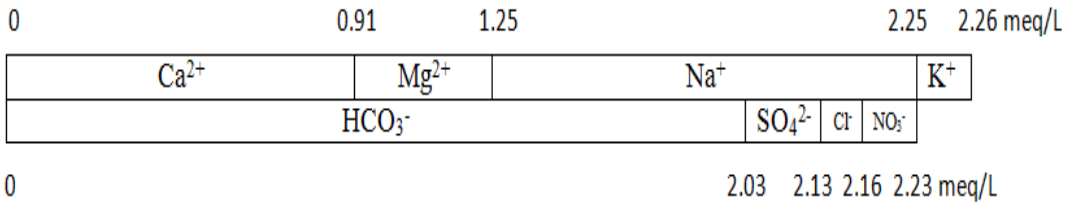
A2- Sample Bar Diagram Calculation of GW-T:

Ion	Cations			Ion	Anions		
	Conc.	Equiv, mq/mequiv	Equiv conc., meq/L		Conc.	Equiv, mq/mequiv	Equiv conc., meq/L
Ca^{2+}	18.11	20	0.91	HCO_3^-	122	61	2.03
Mg^{2+}	4.15	12.15	0.34	SO_4^{2-}	5	48	0.10
Na^+	23	23	1.00	Cl^-	2.55	35.5	0.03
K^+	0.46	39	0.01	NO_3^-	1.67	62	0.07
Total	2.26			Total	2.23		

Percent error % = [∑cation - ∑anion / (∑cation + ∑anion)] x 100

= [2.26 – 2.21 / (2.26+2.23)] x 100

= 0.6 %



A3 - Sulfide concentration Calculation:

$2H_2O + 2S \rightarrow 2H_2S + O_2\uparrow$

Mass of water + mass of sulfur → mass of molecular

Mass of water = 350 ml = 350 gram

Mass of sulfur = 30 gram

350 g + 30 g → 68 g/mol

380 g = 68 g/mol

Sulfide concentration = (68 g/mol) / 380 g

= 0.18 M

APPENDIX B

FESEM ANALYSIS

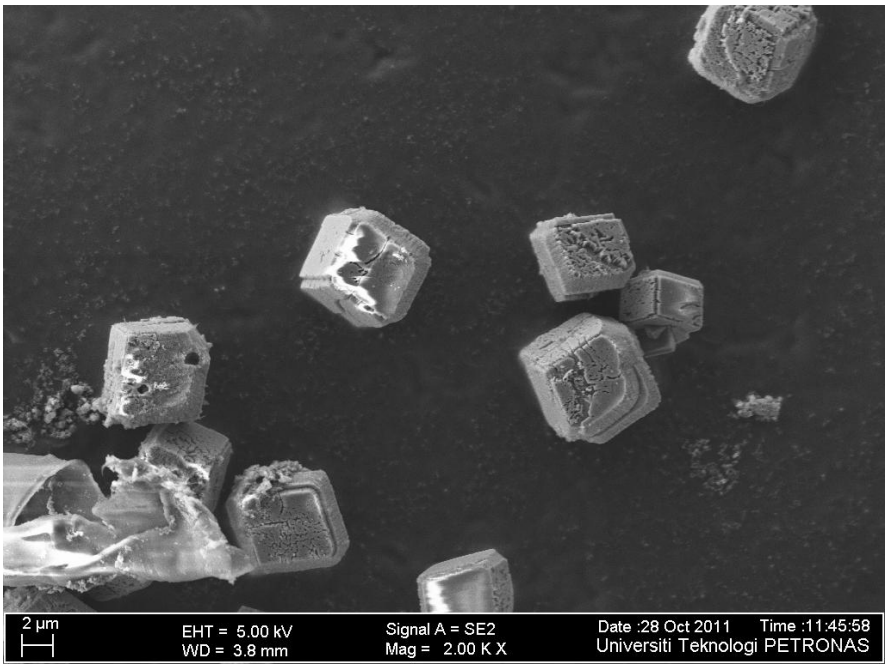


Figure B-1: Formation of pyrite in cube crystal from sample 1

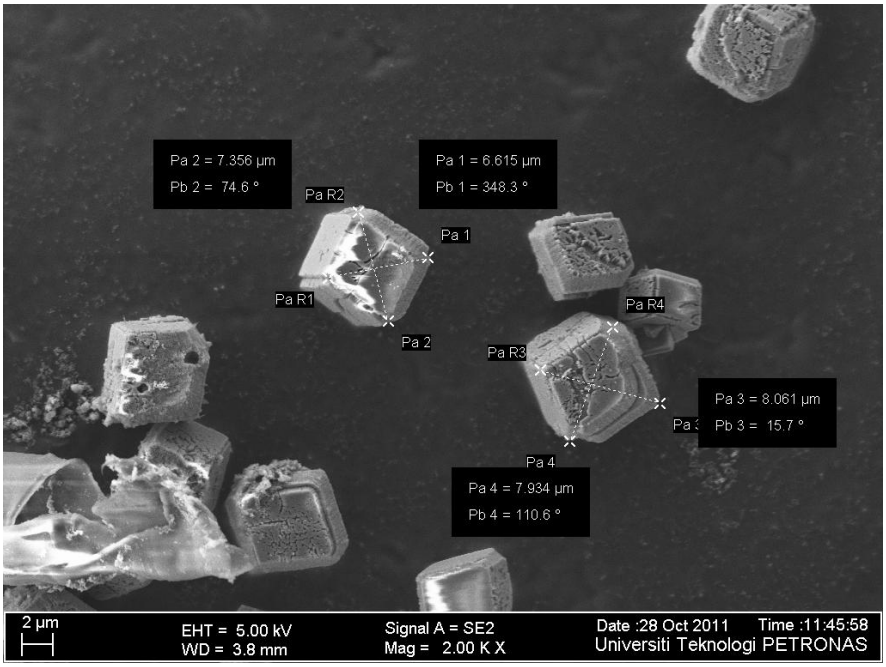


Figure B-2: Size of pyrite from sample 1

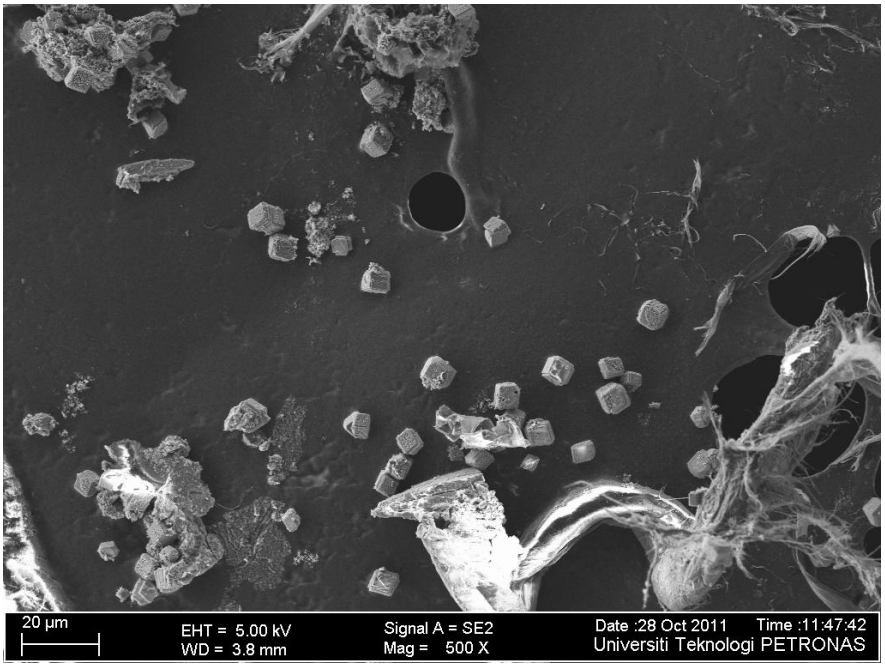


Figure B-3: Formation of pyrite in cube crystal from sample 2

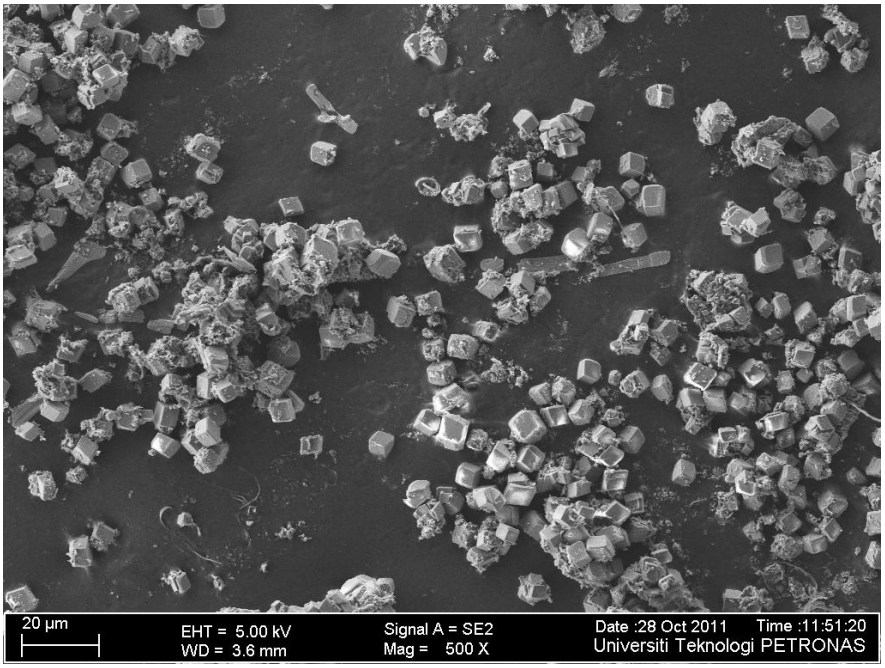


Figure B-4: Formation of pyrite in cube crystal from sample 3

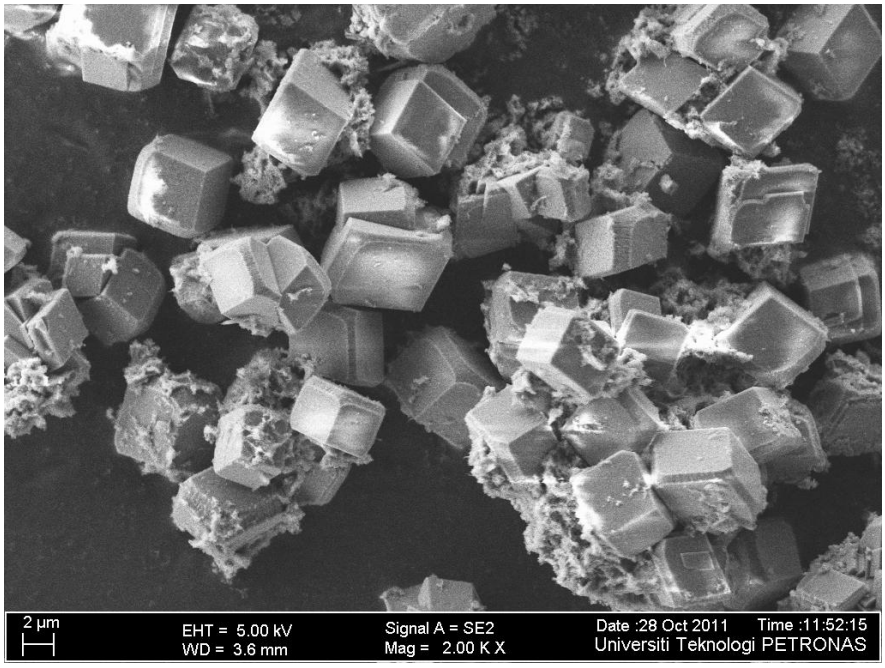


Figure B-5: Formation of pyrite in cube crystal from sample 4

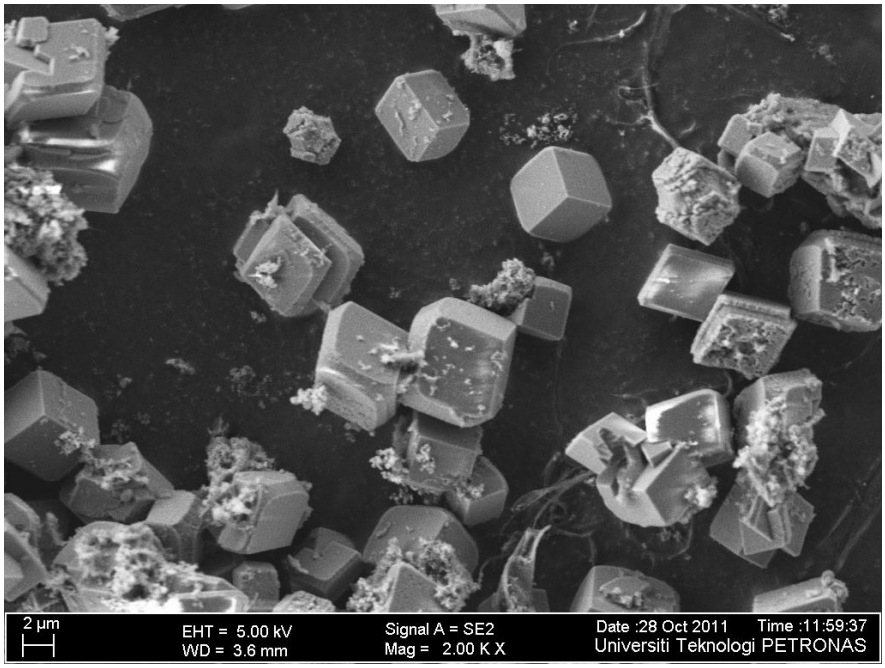


Figure B-6: Formation of pyrite in cube crystal from sample 5

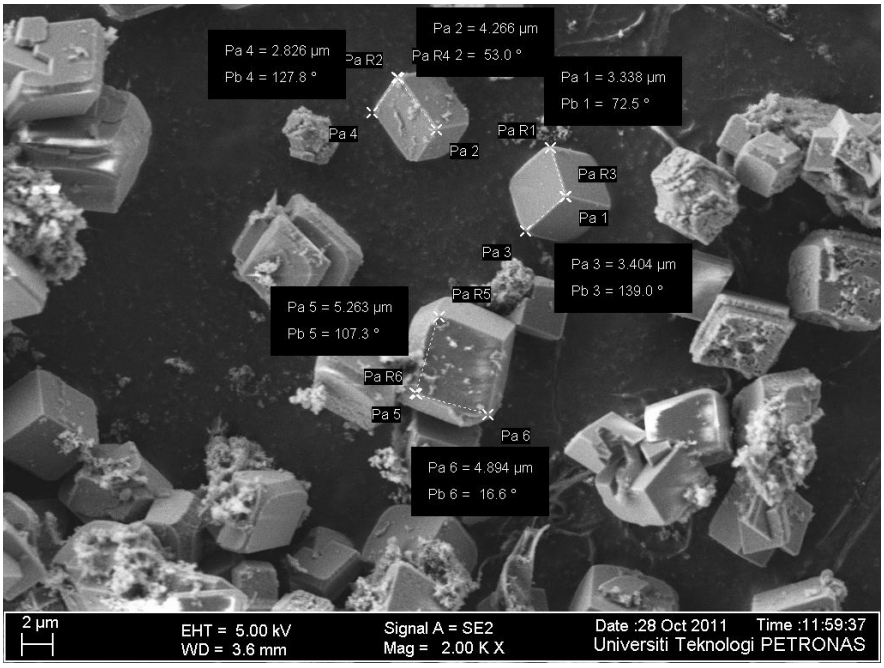


Figure B-7: Size of pyrite in cube crystal from sample 6

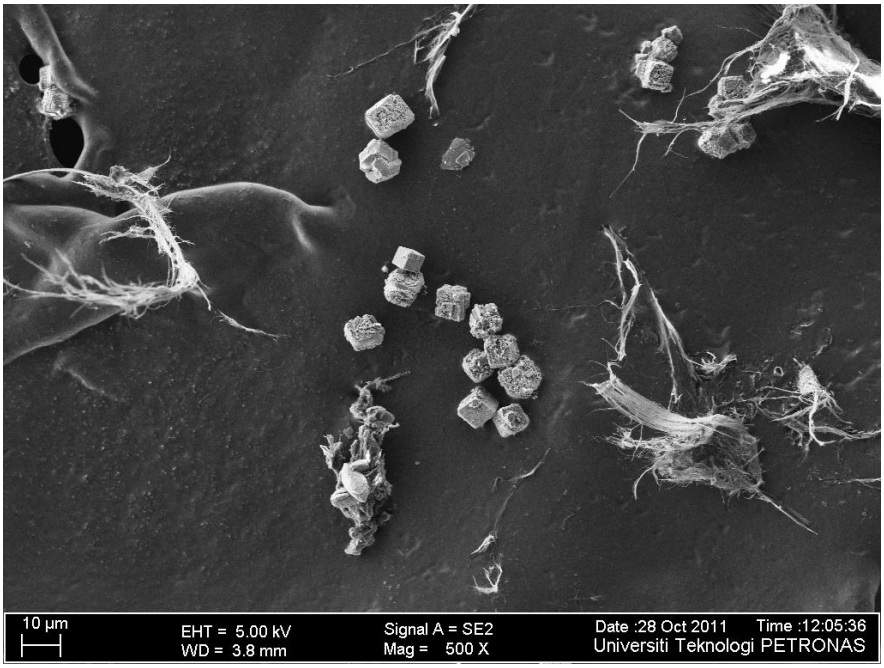


Figure B-8: Formation of pyrite in cube crystal from sample 6

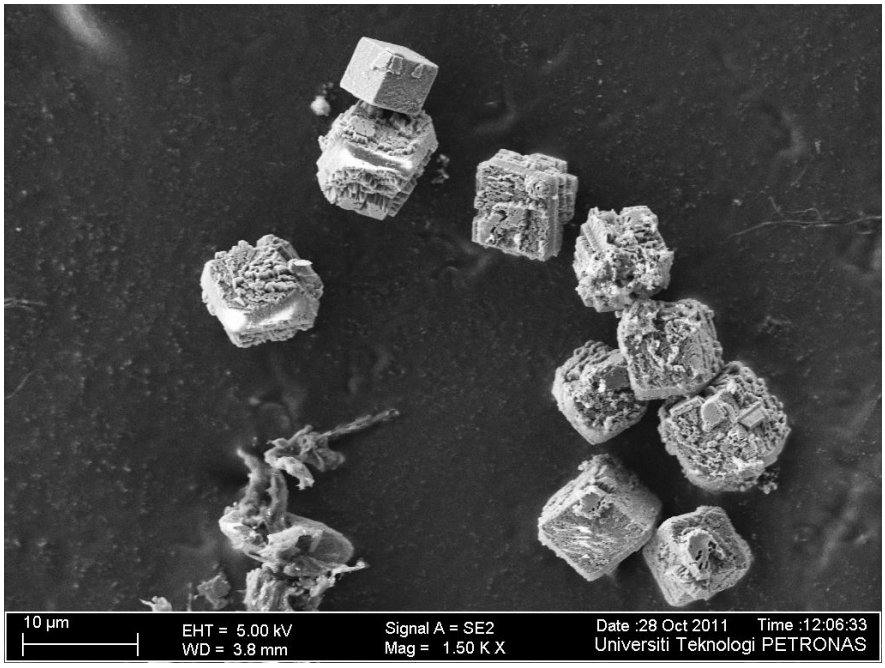


Figure B-9: Formation of pyrite in cube crystal from sample 7

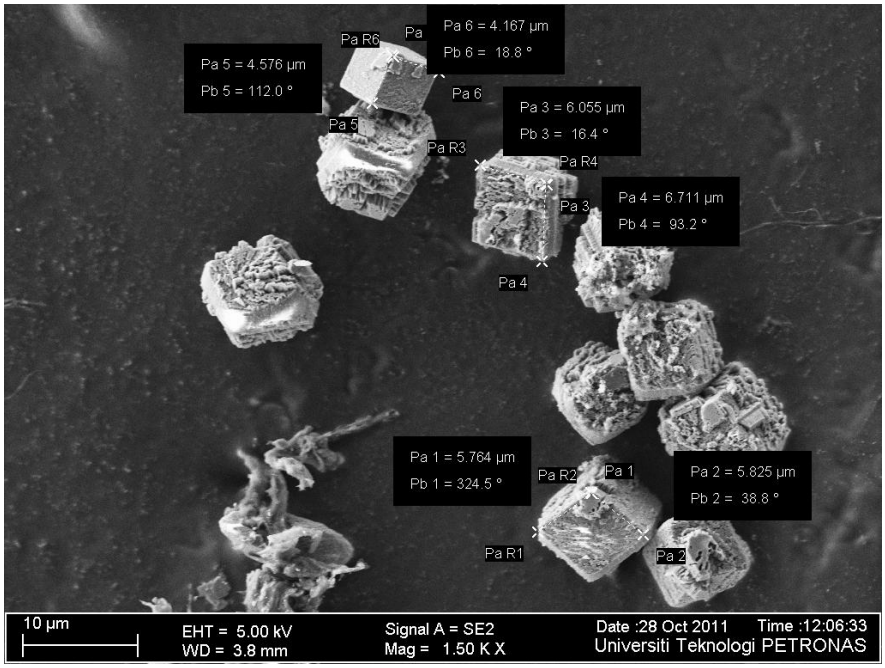


Figure B-10: Size of pyrite in cube crystal from sample 7

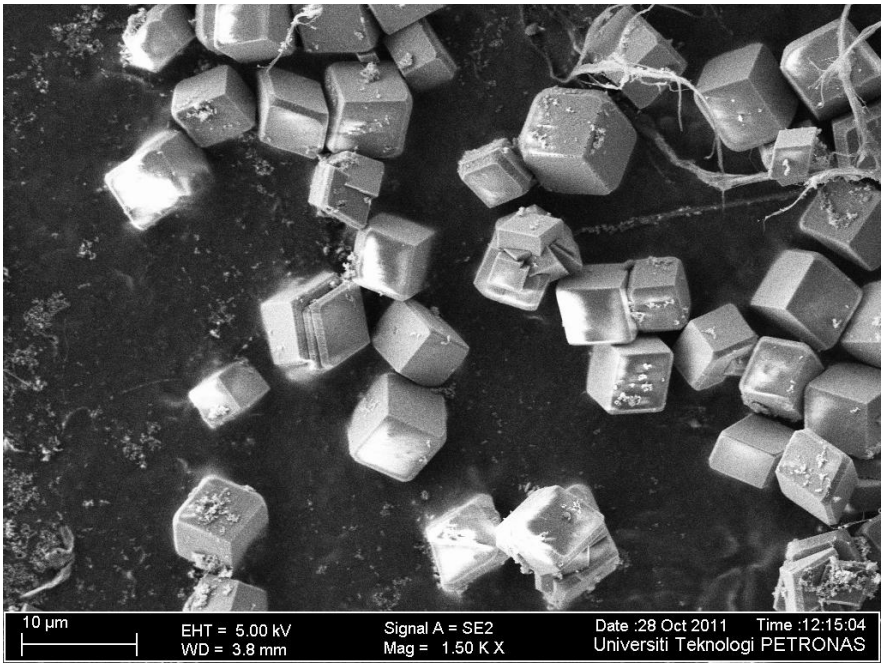


Figure B-11: Formation of pyrite in cube crystal from sample 8

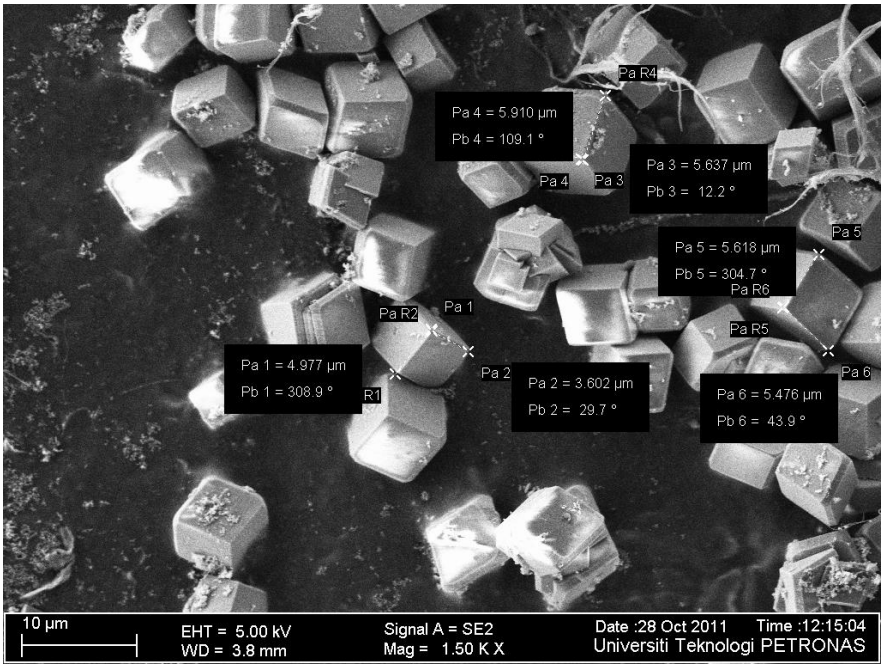


Figure B-12: Size of pyrite in cube crystal from sample 8

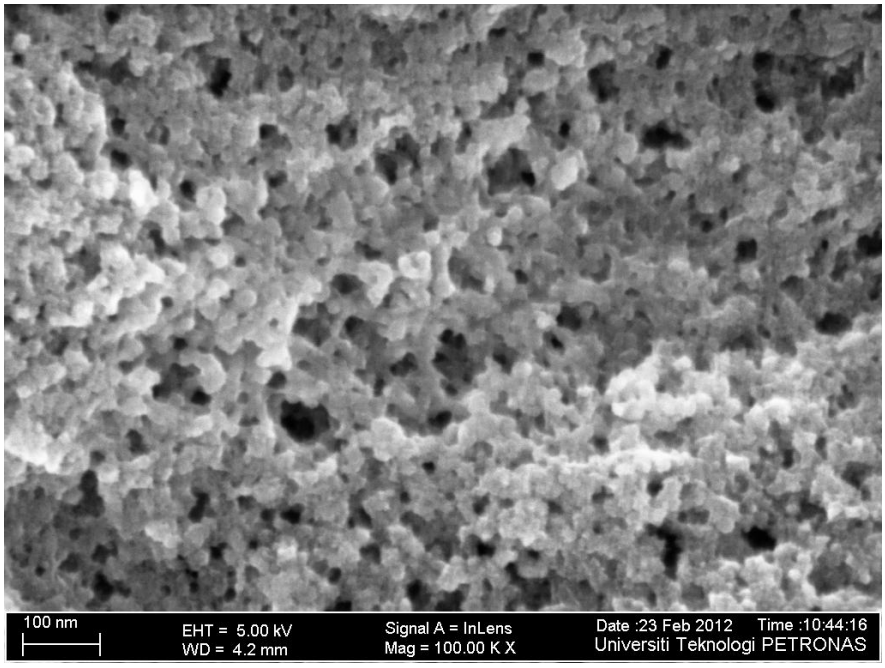


Figure B-13: Precipitated element from EC treatment

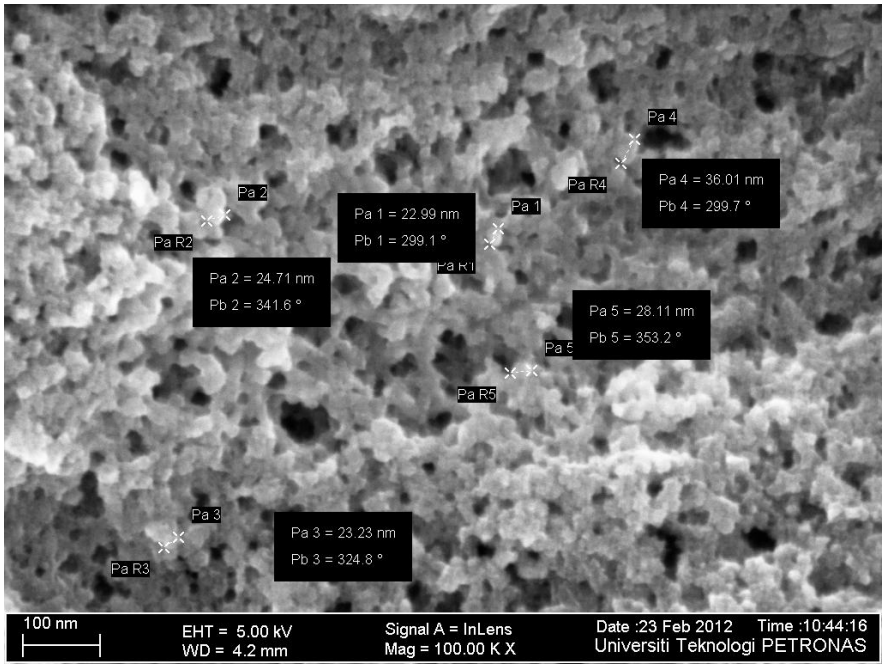


Figure B-14: Size of precipitated elements

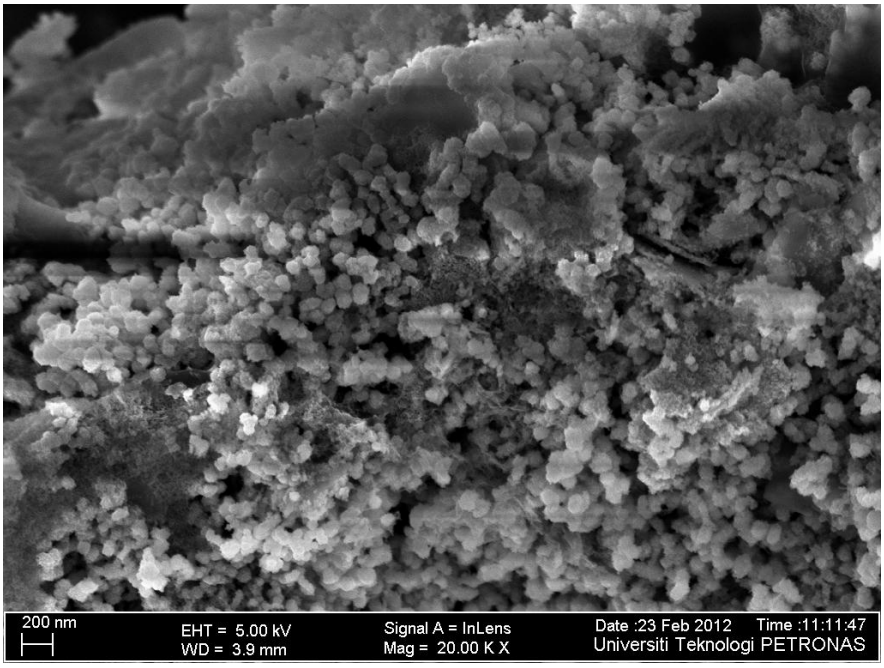


Figure B-15: Formation of precipitated element from EC treatment

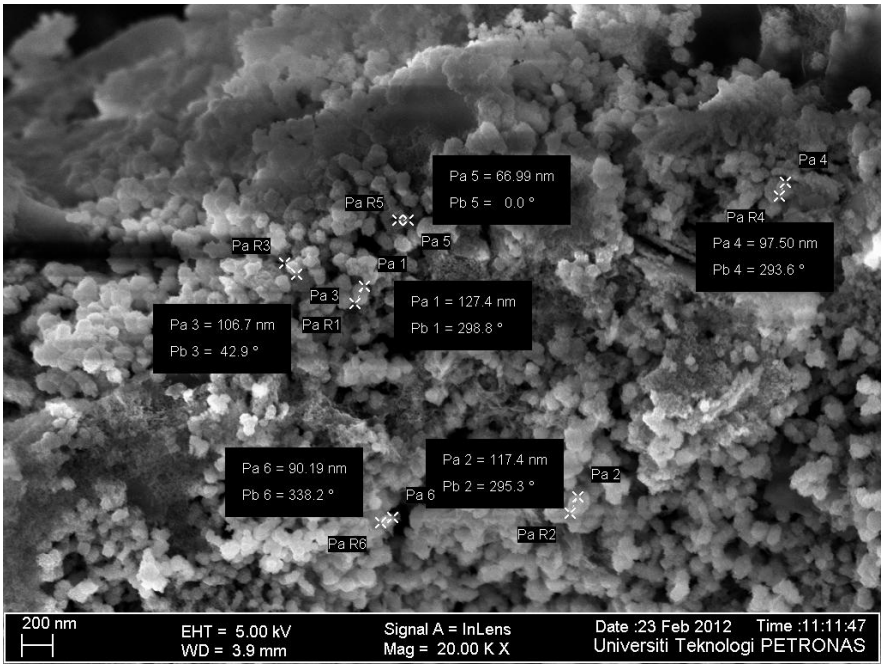


Figure B-16: Size of precipitated elements

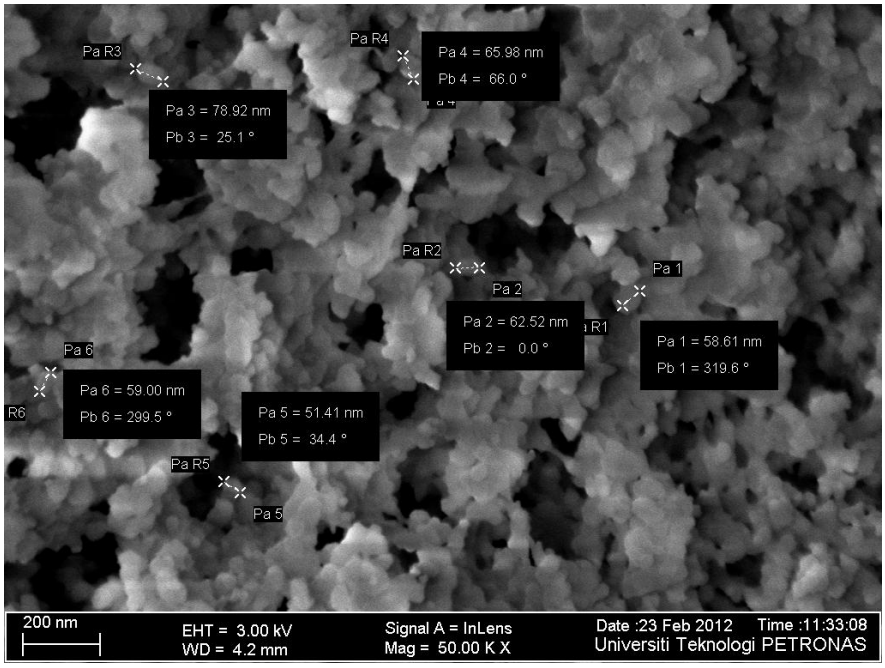


Figure B-17: Size of precipitated elements after EC treatment

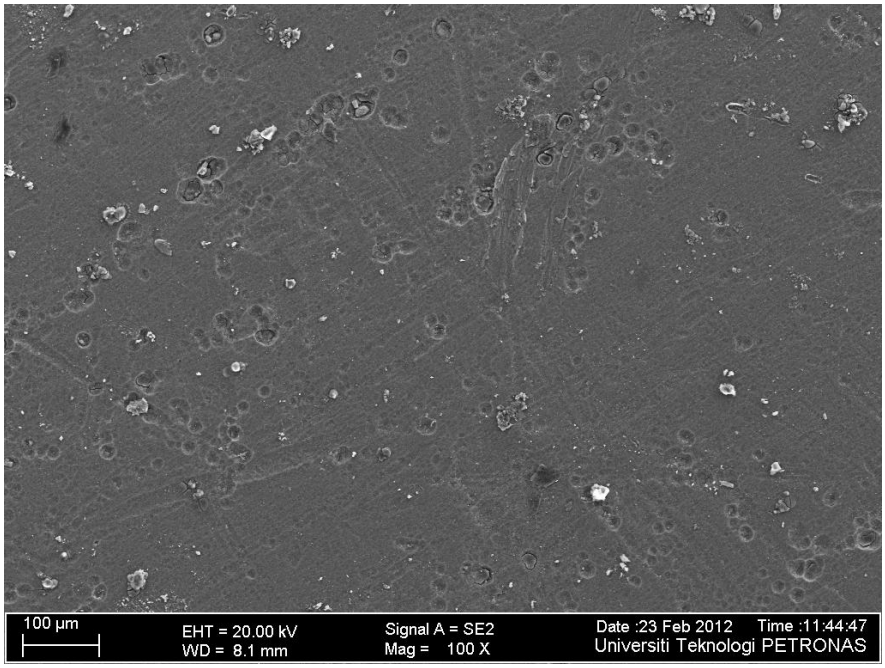


Figure B-18: Surface of aluminium electrode before EC process

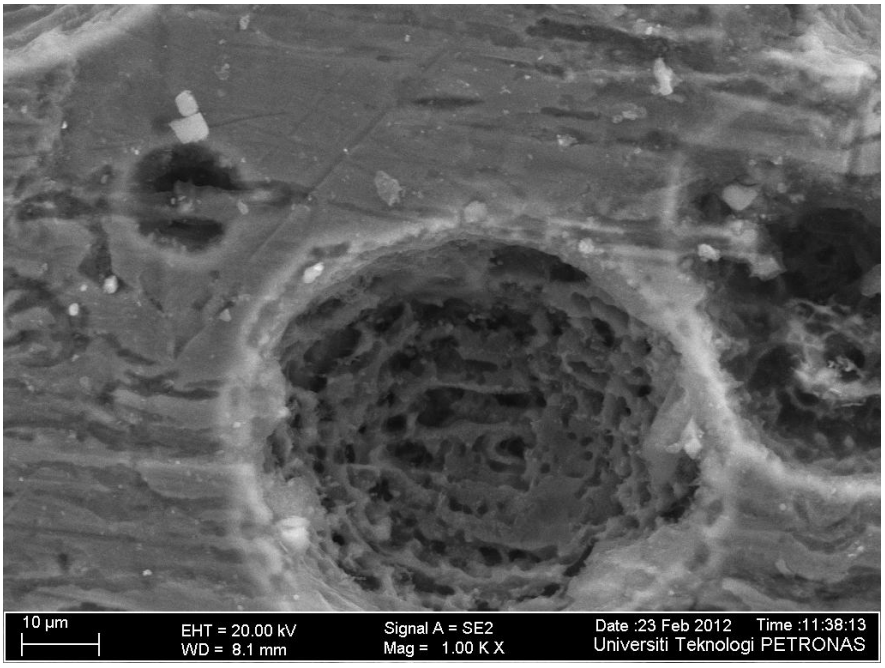


Figure B-19: Surface of aluminium electrode after EC process

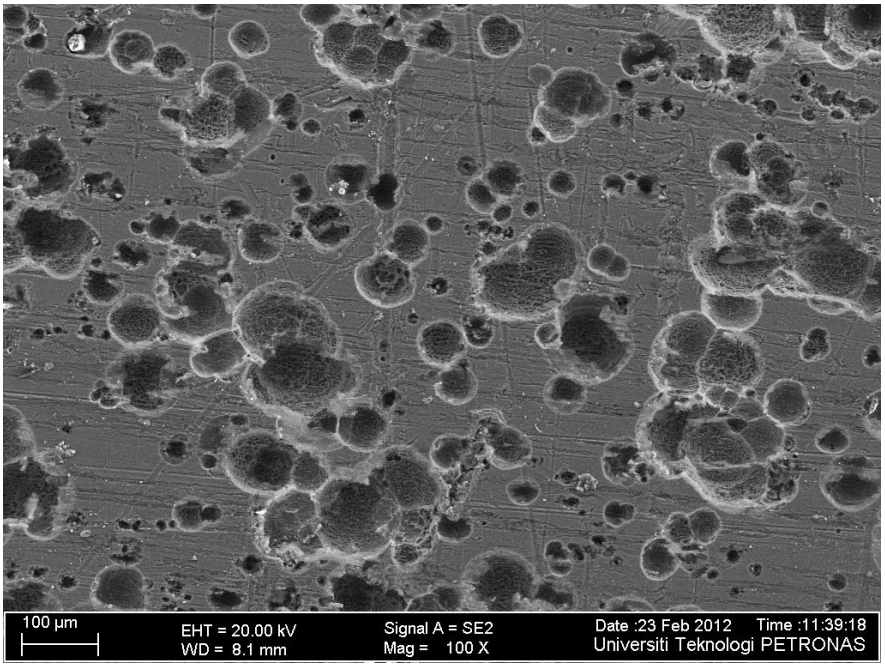


Figure B-20: Surface of aluminium electrode after EC process

APPENDIX C

EDAX ANALYSIS

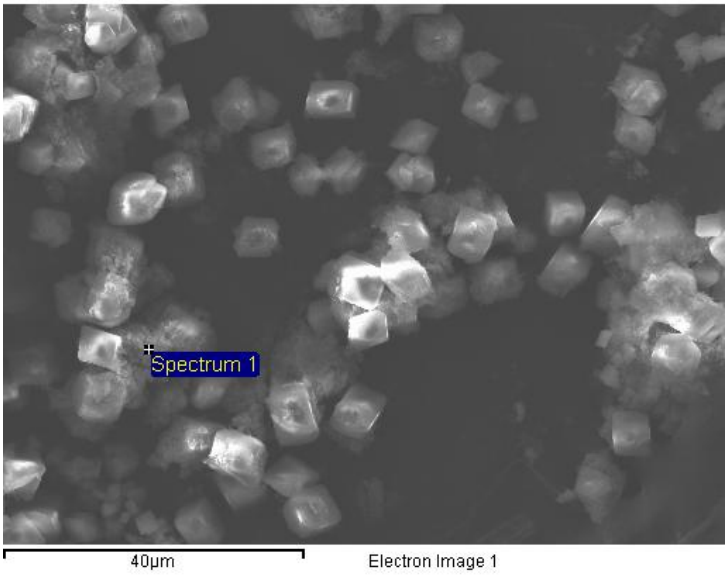


Figure C-1: Spectrum 1 from precipitated image

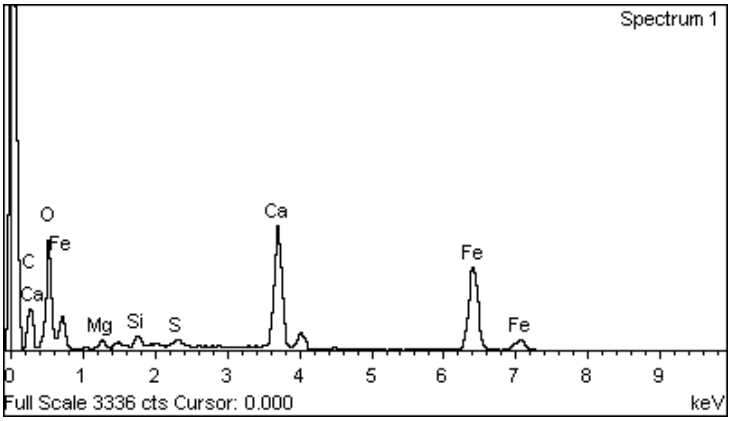


Figure C-2: Spectrum 1 shows pyrite detected

Table C-1: Percentage of weight and atomic from precipitated elements

Element	Weight %	Atomic %
C, $CaCO_3$	21.31	34.74
O, SiO_2	40.33	49.36
Mg, MgO	0.80	0.64
Si, SiO_2	0.79	0.55
S.FeS_2	0.46	0.28
Ca, Wollastonite	12.34	6.03
Fe, Ferum	23.97	8.40
Totals	100.00	

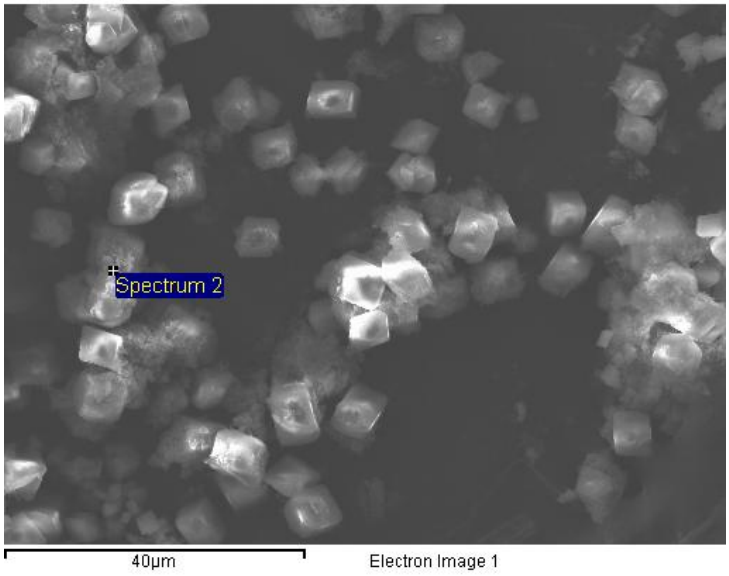


Figure C-3: Spectrum 2 from precipitated image

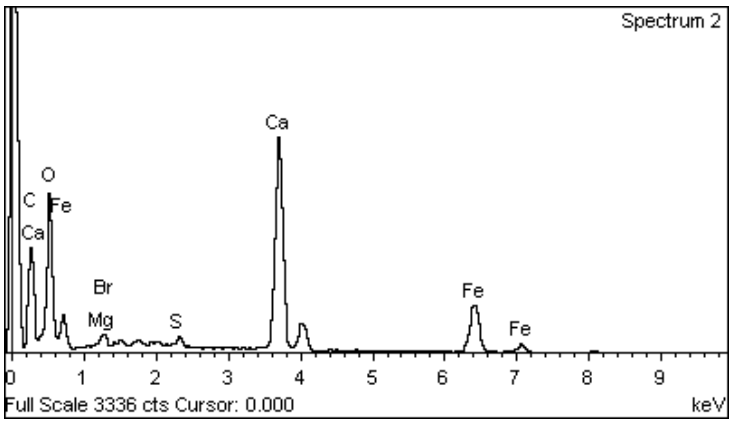


Figure C-4: Spectrum 2 shows pyrite detected

Table C-2: Percentage of weight and atomic from precipitated elements

Element	Weight %	Atomic %
C, $CaCO_3$	25.66	37.37
O, SiO_2	47.55	51.99
Mg, MgO	0.71	0.51
S,FeS_2	0.55	0.30
Ca, Wollastonite	15.18	6.62
Fe, Ferum	9.83	3.08
Br, KBr	0.53	0.12
Totals	100.00	

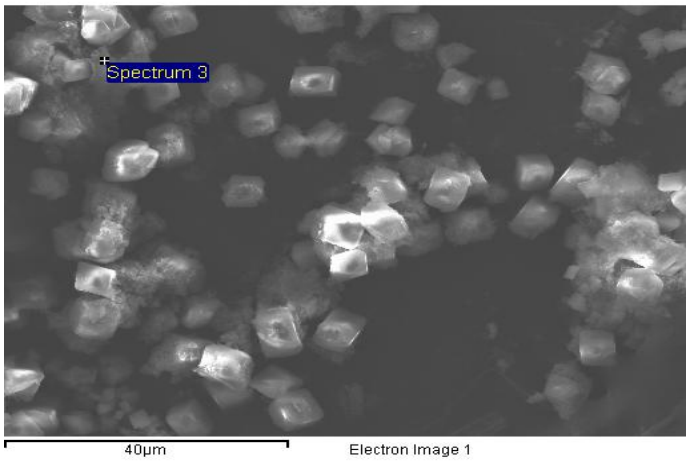


Figure C-5: Spectrum 3 from precipitated image

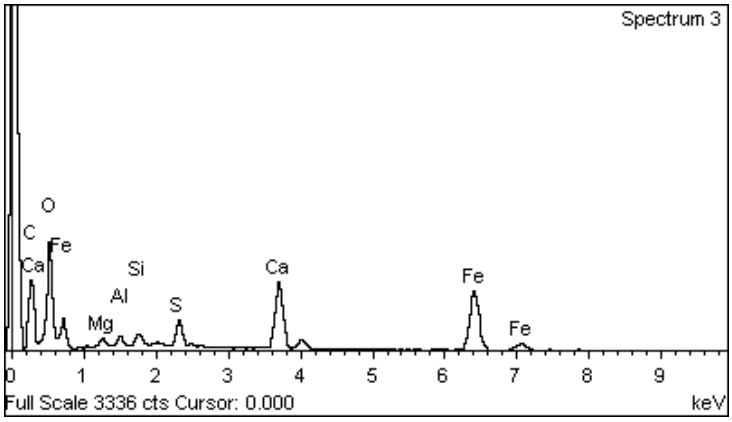


Figure C-6: Spectrum 3 shows pyrite detected

Table C-3: Percentage of weight and atomic from precipitated elements

Element	Weight %	Atomic %
C, $CaCO_3$	32.40	46.33
O, SiO_2	40.33	43.31
Mg, MgO	0.62	0.44
Al,Al_2O_3	0.68	0.43
Si, SiO_2	0.71	0.44
S, FeS_2	2.07	1.11
Ca, Wollastonite	6.72	2.88
Fe, Ferum	16.47	5.07
Totals	100.00	

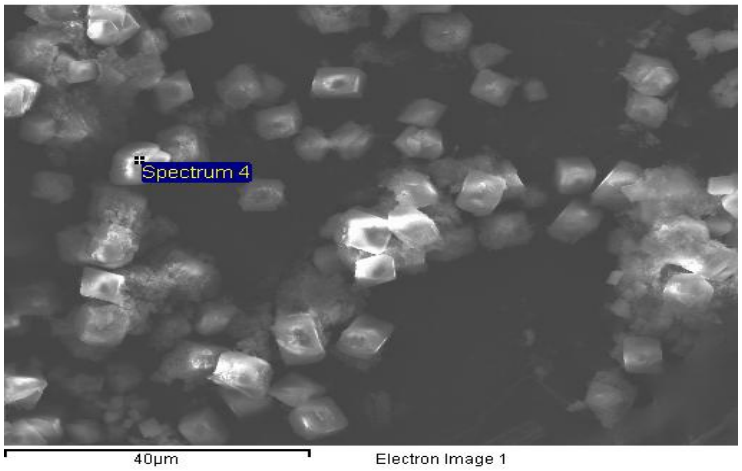


Figure C-7: Spectrum 4 from precipitated image

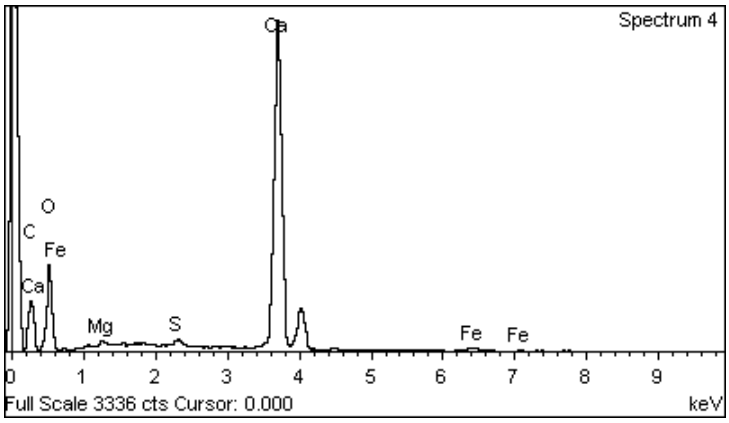


Figure C-8: Spectrum 4 shows pyrite detected

Table C-4: Percentage of weight and atomic from precipitated elements

Element	Weight %	Atomic %
C, $CaCO_3$	16.97	26.49
O, SiO_2	49.14	57.58
Mg, MgO	0.43	0.33
S,FeS_2	0.47	0.28
Ca, Wollastonite	32.14	15.03
Fe, Ferum	0.83	0.28
Totals	100.00	

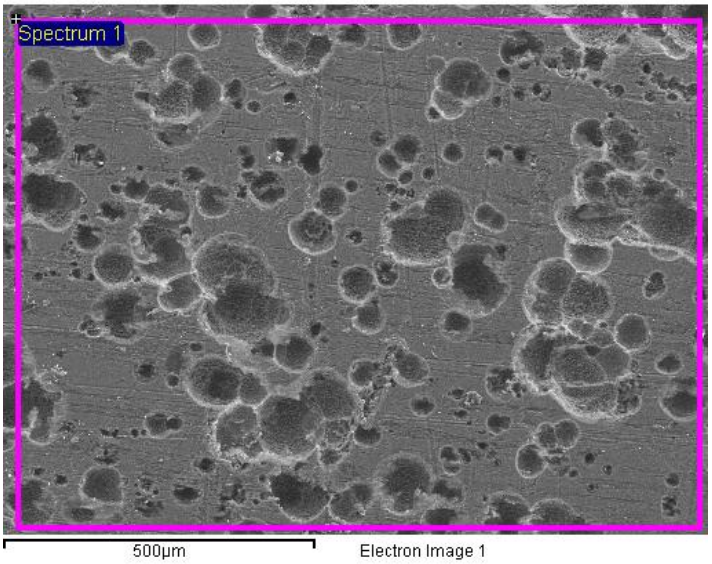


Figure C-9: Spectrum 1 image from electrode's surface after EC process

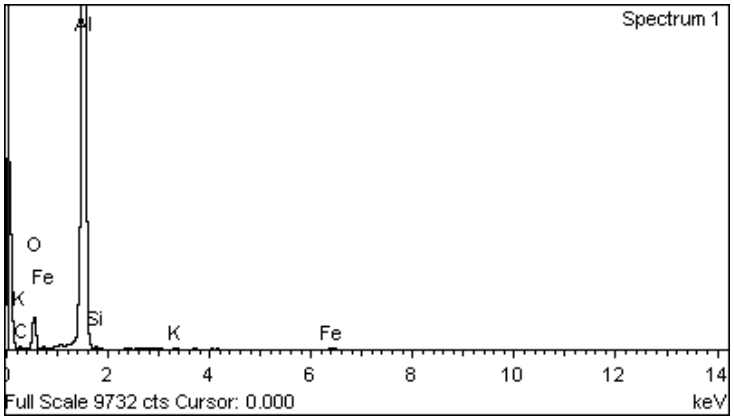


Figure C-10: Spectrum 1 from electrode's surface (iron detected)

Table C-5: Percentage of weight and atomic from elements at electrode's surface

Element	Weight %	Atomic %
C, $CaCO_3$	5.16	9.66
O, SiO_2	20.93	29.41
Al, Al_2O_3	71.82	59.85
Si, SiO2	0.53	0.43
K, Feldspar	0.20	0.11
Fe, Ferum	1.36	0.55
Totals	100.00	

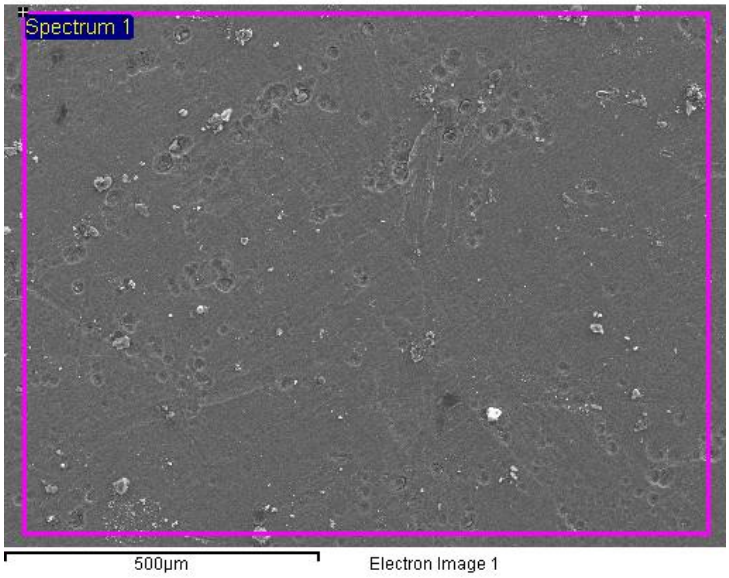


Figure C-11: Spectrum 1 image from electrode's surface after EC process

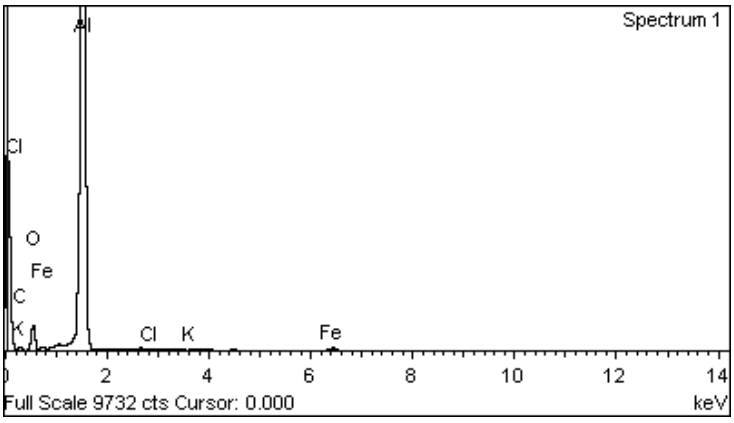


Figure C-12: Spectrum 1 from electrode's surface (iron detected)

Table C-6: Percentage of weight and atomic from elements at electrode's surface

Element	Weight %	Atomic %
C, $CaCO_3$	5.47	10.54
O, SiO_2	15.62	22.58
Al, Al_2O_3	76.90	65.93
Cl, KCl	0.25	0.16
K, Feldspar	0.31	0.18
Fe, Ferum	1.46	0.60
Totals	100.00	

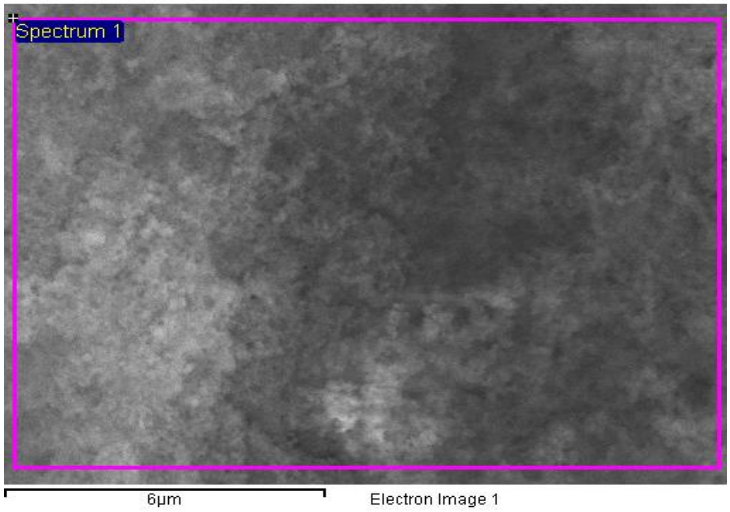


Figure C-13: Spectrum 1 image from precipitated elements after EC process

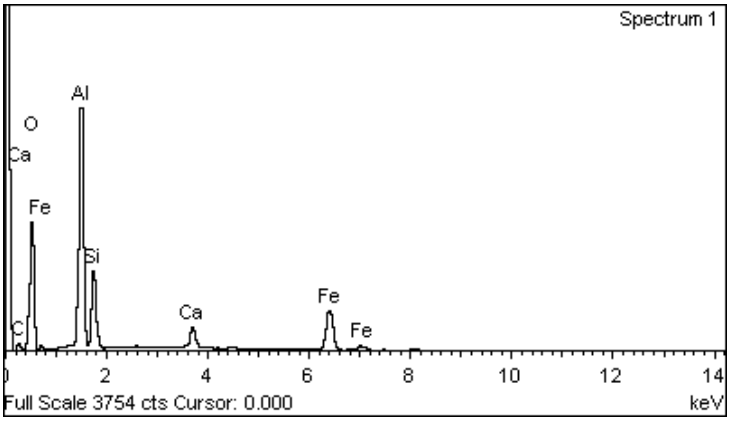


Figure C-14: Spectrum 1 from precipitated elements (iron detected)

Table C-7: Percentage of weight and atomic from precipitated elements

Element	Weight %	Atomic %
C, $CaCO_3$	11.44	18.91
O, SiO_2	43.58	54.09
Al, Al_2O_3	20.61	15.16
Si,SiO_2	7.99	5.65
Ca, Wollastonite	2.62	1.30
Fe, Ferum	13.76	4.89
Totals	100.00	

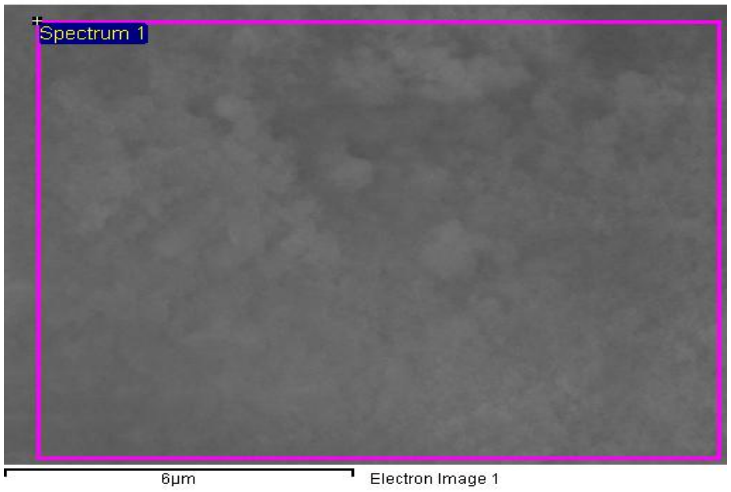


Figure C-15: Spectrum 1 image from electrode's surface after EC process

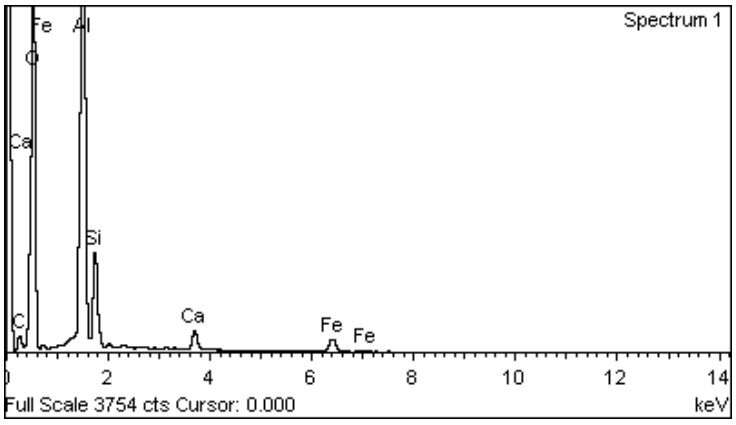


Figure C-16: Spectrum 1 from precipitated elements (iron detected)

Table C-8: Percentage of weight and atomic from precipitated elements

Element	Weight %	Atomic %
C, $CaCO_3$	11.03	16.43
O, SiO_2	56.64	63.32
Al, Al_2O_3	23.84	15.80
Si,SiO_2	4.98	3.17
Ca, Wollastonite	1.21	0.54
Fe, Ferum	2.30	0.74
Totals	100.00	

APPENDIX D

DATA COLLECTION

Table D-1: Data total iron content from different sand well from Syarikat Air Kelantan Sdn. Bhd. (SAKSB)

No.	Name of wells	Iron concentration (mg/L)	Depth of wells
1	LRC-1	5.2	18
2	LRC-2	2.22	16
3	LRC-3	2.32	35
4	FFM-9	1.15	44
5	KMWP-1	1.46	20
6	SPI-1	1.4	17
7	UCA-1	1.22	19
8	UCA-4	1.09	22
9	UCC-5	1.35	90
10	UCC-6A	0.99	20
11	UCC-8	1.45	32
12	UCB-9	3.1	88
13	SC-1	5.82	80
14	SC-2	6.7	100
15	SC-3	3.5	45
16	SC-4	1.92	20
17	SED-1	14.8	110
18	SED-2	1.25	76
19	SED-3	2.4	45
20	SED-4	5.05	38
21	SDP-2	1.72	26
22	FFM-1	5.25	70
23	FFM-4	1.16	82
24	FFM-7	2.91	98
25	TPP-1	2.87	22
26	TPP-2	1.13	65
27	TPP-2	1.13	70
28	CI-1	5	83

Table D-2: Quality of groundwater from UTP (GW-T)

Parameters	Units	GW-T	GW-T	GW-T	WHO Standard	Malaysia Standard
pH		6.79	6.82	6.7	6.5 – 8.5	6.5 – 8.5
DO	mg/L	0.35	0.35	0.45	-	-
Conductivity	µS/cm	250	275	270	-	-
Turbidity	ntu	6.57	6.40	6.68	1	5
Color	Pt.Co	20	25	34	15	15
Total iron (Fe)	mg/L	5.50	5.01	3.55	0.3	0.3
Calcium (Ca^{2+})	mg/L	18.11	17.5	18.42	200	
Magnesium (Mg^{2+})	mg/L	4.15	4.30	4.57	150	-
Natrium (Na^{+})	mg/L	23	18	22	200	200
Potassium (K^{+})	mg/L	0.46	0.41	0.39	-	
Sulphate (SO_4^{2-})	mg/L	1.070	0.937	0.920	250	250
Bicarbonate (HCO_3^{-})	mg/L	122	100	120	-	-
Chloride (Cl^{-})	mg/L	11.60	5.740	3.343	250	250
Sulfide (S^{2-})	µg/L	4	5	4	50	-
Nitrate (NO_3^{-})	mg/L	1.67	1.67	1.66	50	-
Hardness	mg/L as $CaCO_3$	62.29	61.38	64.79	100-300	500
TDS	mg/L	120	130	135	600	1000
Total Alkalinity	mg/L as $CaCO_3$	100	85	100	-	-

Table D-3: Quality of groundwater from UTP (GW-T) and Kg. Chicha (GW-C)

Parameters	Units	GW-T	GW-T	GW-C	WHO Standard	Malaysia Standard
pH		6.79	6.45	6.5	6.5 – 8.5	6.5 – 8.5
DO	mg/L	0.44	0.30	2.37	-	-
Conductivity	µS/cm	225	230	180	-	-
Turbidity	ntu	7.33	6.80	3.1	1	5
Color	Pt.Co	20	22	5	15	15
Total iron (Fe)	mg/L	3.5	1.5	10	0.3	0.3
Calcium (Ca^{2+})	mg/L	17.50	14.43	22.90	200	
Magnesium (Mg^{2+})	mg/L	4.20	4.40	10.3	150	-
Natrium (Na^{+})	mg/L	23	10	5.08	200	200
Potassium (K^{+})	mg/L	0.46	1.20	3.03	-	
Sulphate (SO_4^{2-})	mg/L	1.073	1.08	18	250	250
Bicarbonate (HCO_3^{-})	mg/L	122	110	36.6	-	-
Chloride (Cl^{-})	mg/L	2.55	2.21	16.82	250	250
Sulfide (S^{2-})	µg/L	4	2	1	50	-
Nitrate (NO_3^{-})	mg/L	1.65	5	0.53	50	-
Hardness	mg/L as $CaCO_3$	60.97	54.14	99.48	100 - 300	500
TDS	mg/L	120	110	95	600	1000
Total Alkalinity	mg/L as $CaCO_3$	100	85	80	-	-

Table D-4: Effect pH on removal of iron from initial concentration of 1 mg/L

Time (Hour)	pH 2		pH 3		pH 4		pH 5	
	Conc.	Ave. Conc.	Conc.	Ave. Conc.	Conc.	Ave. Conc.	Conc.	Ave. Conc.
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1.00		1.00		1.00		1.00	
	1.00		1.00		1.00		1.00	
1	0.96	0.95	0.95	0.94	0.92	0.91	0.88	0.88
	0.95		0.94		0.91		0.88	
	0.93		0.93		0.9		0.88	
2	0.93	0.93	0.92	0.92	0.9	0.90	0.8	0.80
	0.93		0.92		0.9		0.8	
	0.93		0.92		0.9		0.8	
3	0.91	0.91	0.89	0.89	0.86	0.86	0.73	0.72
	0.91		0.89		0.86		0.72	
	0.9		0.89		0.86		0.72	
4	0.89	0.90	0.88	0.87	0.85	0.84	0.67	0.67
	0.9		0.86		0.84		0.67	
	0.91		0.86		0.83		0.66	
5	0.87	0.87	0.85	0.85	0.81	0.81	0.6	0.60
	0.87		0.85		0.81		0.6	
	0.87		0.85		0.81		0.59	
6	0.86	0.86	0.82	0.82	0.78	0.78	0.56	0.55
	0.86		0.82		0.78		0.55	
	0.85		0.82		0.77		0.55	

Table D-5: Effect pH on removal of iron from initial concentration of 1 mg/L

Time (Hour)	pH 6		pH 7		pH 8		pH 9	
	Conc.	Ave. Conc.	Conc.	Ave. Conc.	Conc.	Ave. Conc.	Conc.	Ave. Conc.
0	1.00	1.00	1	1.00	1.00	1.00	1.00	1.00
	1.00		1		1.00		1.00	
	1.00		1		1.00		1.00	
1	0.85	0.85	0.81	0.80	0.78	0.78	0.93	0.92
	0.85		0.79		0.78		0.91	
	0.85		0.79		0.78		0.91	
2	0.8	0.80	0.66	0.66	0.66	0.66	0.87	0.87
	0.8		0.66		0.66		0.87	
	0.8		0.66		0.66		0.87	
3	0.72	0.72	0.58	0.58	0.6	0.60	0.84	0.84
	0.72		0.58		0.6		0.84	
	0.72		0.58		0.6		0.83	
4	0.64	0.64	0.35	0.34	0.37	0.37	0.79	0.79
	0.64		0.35		0.37		0.79	
	0.64		0.33		0.37		0.79	
5	0.57	0.56	0.25	0.24	0.35	0.35	0.81	0.78
	0.56		0.24		0.35		0.76	
	0.56		0.23		0.35		0.76	
6	0.5	0.50	0.25	0.25	0.3	0.30	0.76	0.76
	0.5		0.25		0.3		0.76	
	0.49		0.25		0.29		0.75	

Table D-6: Removal of iron over time from initial concentration of 1 mg/L at pH 7

Total Iron 1 mg/L				
Time	Iron Conc.	Ave. Iron Conc.	Removal Efficiency %	pH
0	1.00	1.00	0.00	7.05
	1.00			
	1.01			
30	0.98	0.97	3.00	7.24
	0.97			
	0.97			
60	0.87	0.87	13.00	7.28
	0.87			
	0.87			
90	0.84	0.84	16.00	7.33
	0.84			
	0.83			
120	0.78	0.78	22.00	7.36
	0.78			
	0.79			
150	0.74	0.74	26.00	7.40
	0.74			
	0.74			
180	0.70	0.70	30.00	7.45
	0.70			
	0.69			
210	0.60	0.59	41.00	7.52
	0.58			
	0.58			

Table D-6 (cont.): Removal of iron over time from initial concentration of 1 mg/L at pH 7

Total Iron 1 mg/L				
Time	Iron Conc.	Ave. Iron Conc.	Removal Efficiency %	pH
240	0.50	0.51	49.00	7.57
	0.51			
	0.51			
270	0.47	0.47	53.00	7.59
	0.47			
	0.48			
300	0.45	0.44	56.00	7.61
	0.44			
	0.44			
330	0.35	0.35	65.00	7.65
	0.35			
	0.35			
360	0.26	0.27	73.00	7.70
	0.28			
	0.28			
390	0.26	0.24	76.00	7.44
	0.24			
	0.23			
420	0.24	0.24	76.00	7.80
	0.24			
	0.24			

Table D-8: Effect on 1.5 mg/L initial concentration of iron

Time	Iron Conc.	Ave. Iron Conc.	Sulfide Conc.	Ave. S^{2-} Conc.	pH	Eh
0	1.50	1.50	2.00	2.00	7.20	-57
	1.51		2.00			
	1.50		2.00			
30	1.29	1.30	5.10	5.03	7.32	-69
	1.29		5.00			
	1.32		5.00			
60	1.25	1.26	6.00	6.00	7.35	-80
	1.25		6.00			
	1.27		6.00			
90	1.10	1.10	7.00	7.00	7.38	-94
	1.10		7.00			
	1.10		7.00			
120	0.89	0.90	8.00	7.97	7.41	-117
	0.90		7.90			
	0.91		8.00			
150	0.87	0.87	11.00	11.00	7.45	-125
	0.87		11.00			
	0.87		11.00			
180	0.64	0.64	14.00	14.00	7.50	-133
	0.63		14.00			
	0.65		14.00			
210	0.53	0.52	15.10	15.00	7.55	-153
	0.51		14.90			
	0.51		15.00			
240	0.44	0.44	16.00	16.00	7.56	-185
	0.44		16.00			
	0.44		16.00			
270	0.38	0.38	17.00	17.00	7.60	-208
	0.38		17.00			
	0.38		17.00			
300	0.32	0.31	18.80	19.00	7.62	-215
	0.29		19.20			
	0.31		19.00			
330	0.29	0.28	20.00	20.00	7.64	-240
	0.28		20.00			
	0.28		20.00			
360	0.25	0.25	22.00	22.00	7.68	-290
	0.25		22.00			
	0.25		22.00			

Table D-9: Effect on 3.55 mg/L initial concentration of iron

Time	Iron Conc.	Ave. Iron Conc.	Sulfide Conc.	Ave. S^{2-} Conc.	pH	Eh
0	3.55	3.55	4.00	4.00	7.05	-55
	3.55		4.00			
	3.55		4.00			
30	3.33	3.33	6.00	6.00	7.12	-70
	3.34		6.00			
	3.33		6.00			
60	3.01	3.01	7.90	8.00	7.15	-80
	3.01		8.10			
	3.01		8.00			
90	2.78	2.78	9.00	9.00	7.30	-99
	2.78		9.00			
	2.79		9.00			
120	2.43	2.43	11.00	11.00	7.32	-115
	2.43		11.00			
	2.43		11.00			
150	2.15	2.15	13.00	13.00	7.35	-125
	2.15		13.00			
	2.15		13.00			
180	1.75	1.75	15.00	15.00	7.40	-140
	1.75		15.00			
	1.75		15.00			
210	1.35	1.35	18.10	18.03	7.40	-153
	1.36		18.00			
	1.34		18.00			
240	1.11	1.11	18.90	18.97	7.44	-177
	1.11		19.00			
	1.11		19.00			
270	0.83	0.83	20.00	20.00	7.47	-210
	0.83		20.00			
	0.83		20.00			
300	0.75	0.75	20.80	21.07	7.48	-229
	0.75		21.20			
	0.75		21.20			
330	0.70	0.70	22.00	22.00	7.52	-255
	0.70		22.00			
	0.70		22.00			
360	0.65	0.65	23.00	23.00	7.55	-272
	0.65		23.00			
	0.65		23.00			

Table D-10: Effect on 5.01 mg/L initial concentration of iron

Time	Iron Conc.	Ave. Iron Conc.	Sulfide Conc.	Ave. S^{2-} Conc.	pH	Eh
0	5.02	5.02	7.00	7.00	6.90	-50
	4.95		7.00			
	5.08		7.00			
30	4.65	4.65	8.00	8.00	7.10	-65
	4.65		8.00			
	4.65		8.00			
60	4.22	4.23	12.00	12.00	7.14	-85
	4.22		12.00			
	4.24		12.00			
90	3.80	3.80	15.00	15.00	7.15	-90
	3.80		15.00			
	3.80		15.00			
120	3.65	3.65	17.20	17.00	7.20	-120
	3.65		16.90			
	3.65		16.90			
150	3.32	3.32	19.10	18.97	7.22	-125
	3.32		18.90			
	3.32		18.90			
180	2.96	2.97	22.10	22.03	7.24	-133
	2.98		22.00			
	2.96		22.00			
210	2.64	2.65	24.00	24.00	7.28	-144
	2.64		24.00			
	2.66		24.00			
240	2.45	2.45	26.00	26.00	7.29	-170
	2.45		26.00			
	2.45		26.00			
270	2.20	2.20	27.00	27.00	7.30	-209
	2.20		27.00			
	2.20		27.00			
300	1.97	1.98	29.00	29.00	7.30	-215
	1.99		29.00			
	1.97		29.00			
330	1.67	1.68	30.00	30.00	7.35	-260
	1.67		30.00			
	1.69		30.00			
360	1.24	1.24	30.00	29.67	7.38	-280
	1.24		30.00			

	1.24		29.00			

Table D-11: Effect pH on iron removal under electro-precipitation process at 1 mg/L

pH	Final iron conc. (mg/L)	Average final	Current density (mg/L)
pH 2	0.89	0.89	26.7 mA/cm^2
	0.87		
	0.9		
pH 3	0.77	0.75	26.7 mA/cm^2
	0.75		
	0.73		
pH 4	0.54	0.55	26.7 mA/cm^2
	0.53		
	0.58		
pH 5	0.4	0.40	26.7 mA/cm^2
	0.38		
	0.42		
pH 6	0.35	0.32	26.7 mA/cm^2
	0.33		
	0.29		
pH 7	0.05	0.08	26.7 mA/cm^2
	0.11		
	0.07		
pH 8	0.25	0.26	26.7 mA/cm^2
	0.23		
	0.31		
pH 9	0.53	0.51	26.7 mA/cm^2
	0.44		
	0.56		
pH 10	0.78	0.79	26.7 mA/cm^2
	0.81		
	0.77		

Table D-12: Effect pH on iron removal under electro-precipitation process at 3 mg/L

pH	Final iron conc. (mg/L)	Average final	Current density (mg/L)
pH 2	2.91	2.95	26.7 mA/cm^2
	2.95		
	2.99		
pH 3	2.75	2.81	26.7 mA/cm^2
	3.01		
	2.67		
pH 4	0.66	0.65	26.7 mA/cm^2
	0.72		
	0.56		
pH 5	0.54	0.54	26.7 mA/cm^2
	0.51		
	0.56		
pH 6	0.65	0.66	26.7 mA/cm^2
	0.63		
	0.7		
pH 7	0.28	0.28	26.7 mA/cm^2
	0.29		
	0.26		
pH 8	0.34	0.36	26.7 mA/cm^2
	0.35		
	0.4		
pH 9	1.02	1.06	26.7 mA/cm^2
	1.05		
	1.11		
pH 10	2.55	2.48	26.7 mA/cm^2
	2.34		
	2.56		

Table D-13: Effect pH on iron removal under electro-precipitation process at 5 mg/L

pH	Final iron conc. (mg/L)	Average final	Current density (mg/L)
pH 2	4.78	4.75	26.7 mA/cm^2
	4.67		
	4.8		
pH 3	4.02	4.06	26.7 mA/cm^2
	4.06		
	4.1		
pH 4	3.27	3.28	26.7 mA/cm^2
	3.33		
	3.23		
pH 5	2.91	2.91	26.7 mA/cm^2
	2.94		
	2.89		
pH 6	1.33	1.33	26.7 mA/cm^2
	1.41		
	1.25		
pH 7	0.44	0.40	26.7 mA/cm^2
	0.4		
	0.35		
pH 8	0.73	0.75	26.7 mA/cm^2
	0.72		
	0.8		
pH 9	2.12	2.19	26.7 mA/cm^2
	2.15		
	2.3		
pH 10	4.21	4.20	26.7 mA/cm^2
	4.18		
	4.22		

Table D-14: Rate of iron reduction at 5 cm electrode spacing

Distance	5 cm	Iron Concentration (mg/L)		
Volt	4	5.00		
Time	Conc.	Ave. Conc.	Surface area (cm^2)	Current Density A/cm^2
0	5.02	5.00	11.2	0.03
	4.95			
	5.03			
30	3.44	3.48	11.2	0.03
	3.56			
	3.44			
60	2.06	2.05	11.2	0.03
	2.02			
	2.07			
90	1.30	1.27	11.2	0.03
	1.28			
	1.23			
120	0.78	0.76	11.2	0.03
	0.80			
	0.70			
150	0.45	0.45	11.2	0.03
	0.45			
	0.46			
180	0.33	0.33	11.2	0.03
	0.35			
	0.32			
210	0.27	0.27	11.2	0.03
	0.26			
	0.27			
240	0.23	0.24	11.2	0.03
	0.24			
	0.24			
270	0.18	0.17	11.2	0.03
	0.15			
	0.18			
300	0.13	0.13	11.2	0.03
	0.13			
	0.13			

Table D-15: Rate of iron reduction at 4 cm electrode spacing

Distance	4 cm	Iron Concentration (mg/L)		
Volt	4	5.00		
Time	Conc.	Ave. Conc.	Surface area (cm^2)	Current Density A/cm^2
0	4.97	4.94	11.2	0.03
	4.95			
	4.90			
30	3.55	3.55	11.2	0.03
	3.54			
	3.55			
60	2.14	2.13	11.2	0.03
	2.12			
	2.13			
90	1.30	1.27	11.2	0.03
	1.28			
	1.24			
120	0.90	0.87	11.2	0.03
	0.85			
	0.85			
150	0.52	0.52	11.2	0.03
	0.52			
	0.52			
180	0.33	0.33	11.2	0.03
	0.32			
	0.35			
210	0.25	0.25	11.2	0.03
	0.25			
	0.24			
240	0.18	0.18	11.2	0.03
	0.18			
	0.19			
270	0.14	0.14	11.2	0.03
	0.14			
	0.15			
300	0.10	0.09	11.2	0.03
	0.09			
	0.09			

Table D-16: Rate of iron reduction at 3 cm electrode spacing

Distance	3 cm	Iron Concentration (mg/L)		
Volt	4	5.00		
Time	Conc.	Ave. Conc.	Surface area (cm^2)	Current Density A/cm^2
0	4.94	5.01	11.2	0.03
	5.04			
	5.05			
30	3.35	3.35	11.2	0.03
	3.35			
	3.34			
60	2.05	2.06	11.2	0.03
	2.06			
	2.06			
90	1.10	1.08	11.2	0.03
	1.08			
	1.05			
120	0.87	0.88	11.2	0.03
	0.88			
	0.88			
150	0.54	0.56	11.2	0.03
	0.55			
	0.58			
180	0.34	0.33	11.2	0.03
	0.33			
	0.33			
210	0.24	0.25	11.2	0.03
	0.26			
	0.24			
240	0.19	0.19	11.2	0.03
	0.18			
	0.20			
270	0.19	0.19	11.2	0.03
	0.18			
	0.19			
300	0.15	0.14	11.2	0.03
	0.14			
	0.14			

Table D-17: Rate of iron reduction at 2 cm electrode spacing

Distance	2 cm	Iron Concentration (mg/L)		
Volt	4	5.00		
Time	Conc.	Ave. Conc.	Surface area (cm^2)	Current Density A/cm^2
0	5.02	5.02	11.2	0.03
	5.02			
	5.03			
30	3.33	3.33	11.2	0.03
	3.33			
	3.33			
60	2.01	2.03	11.2	0.03
	2.05			
	2.03			
90	1.24	1.23	11.2	0.03
	1.23			
	1.23			
120	0.77	0.74	11.2	0.03
	0.73			
	0.72			
150	0.44	0.44	11.2	0.03
	0.45			
	0.43			
180	0.27	0.28	11.2	0.03
	0.29			
	0.28			
210	0.23	0.24	11.2	0.03
	0.23			
	0.25			
240	0.16	0.17	11.2	0.03
	0.18			
	0.18			
270	0.12	0.12	11.2	0.03
	0.12			
	0.12			
300	0.07	0.06	11.2	0.03
	0.07			
	0.04			

Table D-18: Rate of iron reduction at 1 cm electrode spacing

Distance	1 cm	Iron Concentration (mg/L)		
Volt	4	5.00		
Time	Conc.	Ave. Conc.	Surface area (cm^2)	Current Density A/cm^2
0	5.02	5.00	11.2	0.03
	4.95			
	5.03			
30	3.40	3.40	11.2	0.03
	3.41			
	3.39			
60	2.04	1.97	11.2	0.03
	1.98			
	1.90			
90	1.04	1.09	11.2	0.03
	1.10			
	1.12			
120	0.54	0.54	11.2	0.03
	0.54			
	0.54			
150	0.26	0.28	11.2	0.03
	0.29			
	0.28			
180	0.21	0.22	11.2	0.03
	0.22			
	0.22			
210	0.15	0.15	11.2	0.03
	0.15			
	0.16			
240	0.13	0.12	11.2	0.03
	0.13			
	0.10			
270	0.08	0.08	11.2	0.03
	0.09			
	0.06			
300	0.04	0.04	11.2	0.03
	0.05			
	0.02			

Table D-19: Effect 6 volt at 5 mg/L iron concentration using EC technique

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.01	5.02	0.07	11.2	0.006
	5.01				
	5.03				
30	4.45	4.45	0.07	11.2	0.006
	4.50				
	4.40				
60	3.37	3.38	0.07	11.2	0.006
	3.38				
	3.39				
90	2.80	2.79	0.07	11.2	0.006
	2.80				
	2.78				
120	2.20	2.20	0.07	11.2	0.006
	2.20				
	2.20				
150	1.56	1.55	0.07	11.2	0.006
	1.54				
	1.55				
180	0.98	0.97	0.07	11.2	0.006
	0.96				
	0.96				
210	0.52	0.50	0.07	11.2	0.006
	0.48				
	0.50				
240	0.33	0.30	0.07	11.2	0.006
	0.28				
	0.28				
270	0.26	0.27	0.07	11.2	0.006
	0.27				
	0.28				
300	0.19	0.18	0.07	11.2	0.006
	0.19				
	0.15				

Table D-20: Effect 8 volt at 5 mg/L iron concentration using EC technique

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.02	5.02	0.09	11.2	0.008
	5.02				
	5.03				
30	3.46	3.52	0.09	11.2	0.008
	3.56				
	3.55				
60	2.06	2.05	0.09	11.2	0.008
	2.05				
	2.05				
90	1.32	1.31	0.09	11.2	0.008
	1.28				
	1.32				
120	0.78	0.75	0.09	11.2	0.008
	0.78				
	0.70				
150	0.44	0.45	0.09	11.2	0.008
	0.44				
	0.46				
180	0.32	0.32	0.09	11.2	0.008
	0.33				
	0.32				
210	0.28	0.27	0.09	11.2	0.008
	0.26				
	0.28				
240	0.23	0.23	0.09	11.2	0.008
	0.23				
	0.24				
270	0.18	0.18	0.09	11.2	0.008
	0.17				
	0.18				
300	0.13	0.13	0.09	11.2	0.008
	0.13				
	0.12				

Table D-21: Effect 10 volt at 5 mg/L iron concentration using EC technique

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.02	5.00	0.12	11.2	0.011
	4.95				
	5.03				
30	3.40	3.40	0.12	11.2	0.011
	3.41				
	3.39				
60	2.04	1.97	0.12	11.2	0.011
	1.98				
	1.90				
90	1.04	1.09	0.12	11.2	0.011
	1.10				
	1.12				
120	0.54	0.54	0.12	11.2	0.011
	0.54				
	0.54				
150	0.45	0.45	0.12	11.2	0.011
	0.45				
	0.44				
180	0.26	0.28	0.12	11.2	0.011
	0.29				
	0.28				
210	0.21	0.22	0.12	11.2	0.011
	0.22				
	0.22				
240	0.15	0.15	0.12	11.2	0.011
	0.15				
	0.16				
270	0.13	0.12	0.12	11.2	0.011
	0.13				
	0.10				
300	0.08	0.08	0.12	11.2	0.011
	0.09				
	0.06				

Table D-22: Effect 15 volt at 5 mg/L iron concentration using EC technique

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	4.97	4.97	0.15	11.2	0.013
	4.95				
	4.98				
30	3.58	3.57	0.15	11.2	0.013
	3.56				
	3.56				
60	2.20	2.17	0.15	11.2	0.013
	2.15				
	2.17				
90	1.28	1.27	0.15	11.2	0.013
	1.27				
	1.27				
120	0.74	0.75	0.15	11.2	0.013
	0.77				
	0.73				
150	0.27	0.24	0.15	11.2	0.013
	0.23				
	0.23				
180	0.18	0.17	0.15	11.2	0.013
	0.17				
	0.16				
210	0.12	0.20	0.15	11.2	0.013
	0.24				
	0.24				
240	0.19	0.18	0.15	11.2	0.013
	0.18				
	0.18				
270	0.14	0.15	0.15	11.2	0.013
	0.15				
	0.15				
300	0.13	0.12	0.15	11.2	0.013
	0.12				
	0.12				

Table D-23: Effect 20 volt at 5 mg/L iron concentration using EC technique

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.02	5.02	0.35	11.2	0.031
	5.02				
	5.03				
30	3.28	3.28	0.35	11.2	0.031
	3.28				
	3.28				
60	1.97	1.98	0.35	11.2	0.031
	1.99				
	1.97				
90	0.99	0.99	0.35	11.2	0.031
	0.99				
	0.99				
120	0.55	0.55	0.35	11.2	0.031
	0.55				
	0.55				
150	0.31	0.29	0.35	11.2	0.031
	0.28				
	0.28				
180	0.14	0.13	0.35	11.2	0.031
	0.13				
	0.13				
210	0.08	0.07	0.35	11.2	0.031
	0.08				
	0.06				
240	0.03	0.04	0.35	11.2	0.031
	0.03				
	0.05				
270	0.00	0.00	0.35	11.2	0.031
	0.00				
	0.00				
300	0.00	0.00	0.35	11.2	0.031
	0.00				
	0.00				

Table D-24: Result 22.4 cm^2 surface area on treatment of 5 mg/L iron at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.01	5.02	0.68	22.4	0.030
	5.01				
	5.03				
30	3.33	3.33	0.68	22.4	0.030
	3.33				
	3.33				
60	1.84	1.88	0.68	22.4	0.030
	1.85				
	1.96				
90	0.74	0.75	0.68	22.4	0.030
	0.77				
	0.73				
120	0.44	0.43	0.68	22.4	0.030
	0.42				
	0.44				
150	0.31	0.30	0.68	22.4	0.030
	0.31				
	0.28				
180	0.24	0.24	0.68	22.4	0.030
	0.24				
	0.24				
210	0.18	0.18	0.68	22.4	0.030
	0.19				
	0.18				
240	0.12	0.13	0.68	22.4	0.030
	0.13				
	0.14				
270	0.07	0.09	0.68	22.4	0.030
	0.09				
	0.10				
300	0.00	0.00	0.68	22.4	0.030
	0.00				
	0.00				

Table D-25: Result 33.6 cm^2 surface area on treatment of 5 mg/L iron at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	4.93	4.99	1.02	33.6	0.030
	5.01				
	5.03				
30	3.33	3.33	1.02	33.6	0.030
	3.33				
	3.32				
60	1.58	1.61	1.02	33.6	0.030
	1.62				
	1.63				
90	0.96	0.97	1.02	33.6	0.030
	0.96				
	0.98				
120	0.52	0.50	1.02	33.6	0.030
	0.48				
	0.50				
150	0.30	0.29	1.02	33.6	0.030
	0.28				
	0.28				
180	0.19	0.16	1.02	33.6	0.030
	0.14				
	0.16				
210	0.05	0.05	1.02	33.6	0.030
	0.05				
	0.06				
240	0.00	0.00	1.02	33.6	0.030
	0.00				
	0.00				
270	0.00	0.00	1.02	33.6	0.030
	0.00				
	0.00				
300	0.00	0.00	1.02	33.6	0.030
	0.00				
	0.00				

Table D-26: Result 45 cm^2 surface area on treatment of 5 mg/L iron at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.05	5.04	1.44	45	0.032
	5.05				
	5.03				
30	3.12	3.11	1.44	45	0.032
	3.12				
	3.10				
60	1.83	1.87	1.44	45	0.032
	1.89				
	1.88				
90	0.76	0.77	1.44	45	0.032
	0.76				
	0.78				
120	0.26	0.27	1.44	45	0.032
	0.26				
	0.28				
150	0.12	0.13	1.44	45	0.032
	0.13				
	0.13				
180	0.08	0.07	1.44	45	0.032
	0.07				
	0.06				
210	0.03	0.04	1.44	45	0.032
	0.03				
	0.05				
240	0.00	0.00	1.44	45	0.032
	0.00				
	0.00				
270	0.00	0.00	1.44	45	0.032
	0.00				
	0.00				
300	0.00	0.00	1.44	45	0.032
	0.00				
	0.00				

Table D-27: Result 60 cm^2 surface area on treatment of 5 mg/L iron at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	4.97	4.98	1.82	60	0.030
	4.98				
	4.98				
30	1.24	1.24	1.82	60	0.030
	1.24				
	1.24				
60	0.77	0.77	1.82	60	0.030
	0.77				
	0.77				
90	0.29	0.28	1.82	60	0.030
	0.26				
	0.28				
150	0.20	0.21	1.82	60	0.030
	0.21				
	0.23				
180	0.12	0.11	1.82	60	0.030
	0.11				
	0.11				
210	0.06	0.05	1.82	60	0.030
	0.05				
	0.05				
240	0.02	0.03	1.82	60	0.030
	0.03				
	0.03				
270	0.00	0.00	1.82	60	0.030
	0.00				
	0.18				
270	0.00	0.00	1.82	60	0.030
	0.00				
	0.18				
300	0.00	0.00	1.82	60	0.030
	0.00				
	0.00				

Table D-28: Result 75 cm^2 surface area on treatment of 5 mg/L iron at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	4.98	5.00	2.25	75	0.030
	4.98				
	5.03				
30	1.56	1.55	2.25	75	0.030
	1.54				
	1.54				
60	0.29	0.29	2.25	75	0.030
	0.28				
	0.29				
90	0.12	0.12	2.25	75	0.030
	0.12				
	0.13				
120	0.05	0.05	2.25	75	0.030
	0.04				
	0.05				
150	0.00	0.00	2.25	75	0.030
	0.00				
	0.00				
180	0.00	0.00	2.25	75	0.030
	0.00				
	0.00				
210	0.00	0.00	2.25	75	0.030
	0.00				
	0.00				
240	0.00	0.00	2.25	75	0.030
	0.00				
	0.00				
270	0.00	0.00	2.25	75	0.030
	0.00				
	0.00				
300	0.00	0.00	2.25	75	0.030
	0.00				
	0.00				

Table D-29: Result 90 cm^2 surface area on treatment of 5 mg/L iron at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.03	5.03	2.82	90	0.031
	5.02				
	5.03				
30	0.28	0.28	2.82	90	0.031
	0.27				
	0.30				
60	0.16	0.14	2.82	90	0.031
	0.12				
	0.14				
90	0.08	0.06	2.82	90	0.031
	0.07				
	0.04				
120	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
150	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
180	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
210	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				

Table D-30: Effect 5 mg/L iron concentration during EC treatment at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	5.01	5.02	2.80	90	0.031
	5.01				
	5.03				
30	0.26	0.28	2.80	90	0.031
	0.28				
	0.30				
60	0.18	0.19	2.80	90	0.031
	0.19				
	0.19				
90	0.05	0.05	2.80	90	0.031
	0.06				
	0.04				
120	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
150	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
180	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
210	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				

Table D-31: Effect 10 mg/L iron concentration during EC treatment at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	9.90	9.97	2.78	90	0.031
	9.99				
	10.02				
30	3.44	3.45	2.78	90	0.031
	3.44				
	3.46				
60	0.32	0.36	2.78	90	0.031
	0.35				
	0.42				
90	0.24	0.24	2.78	90	0.031
	0.23				
	0.24				
120	0.12	0.12	2.78	90	0.031
	0.12				
	0.12				
150	0.05	0.05	2.78	90	0.031
	0.05				
	0.04				
180	0.00	0.00	2.78	90	0.031
	0.00				
	0.00				
210	0.00	0.00	2.78	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.78	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.78	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.78	90	0.031
	0.00				
	0.00				

Table D-32: Effect 15 mg/L iron concentration during EC treatment at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	15.03	15.00	2.80	90	0.031
	14.98				
	14.99				
30	2.22	2.22	2.80	90	0.031
	2.23				
	2.22				
60	0.76	0.76	2.80	90	0.031
	0.77				
	0.76				
90	0.21	0.23	2.80	90	0.031
	0.24				
	0.25				
120	0.07	0.06	2.80	90	0.031
	0.07				
	0.04				
150	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
180	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
210	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				

Table D-33: Effect 20 mg/L iron concentration during EC treatment at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	19.97	19.98	2.82	90	0.031
	19.98				
	19.98				
30	6.34	6.34	2.82	90	0.031
	6.35				
	6.34				
60	1.15	1.15	2.82	90	0.031
	1.15				
	1.14				
90	0.87	0.89	2.82	90	0.031
	0.89				
	0.90				
120	0.25	0.26	2.82	90	0.031
	0.26				
	0.28				
150	0.11	0.10	2.82	90	0.031
	0.11				
	0.09				
180	0.03	0.03	2.82	90	0.031
	0.03				
	0.04				
210	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.82	90	0.031
	0.00				
	0.00				

Table D-34: Effect 300 ml volume of iron solution at 20 mg/L concentration at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	19.90	19.93	2.80	90	0.031
	19.94				
	19.95				
30	0.98	1.01	2.80	90	0.031
	1.02				
	1.03				
60	0.22	0.22	2.80	90	0.031
	0.23				
	0.20				
90	0.05	0.04	2.80	90	0.031
	0.04				
	0.04				
120	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
150	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
180	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
210	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.80	90	0.031
	0.00				
	0.00				

Table D-35: Effect 500 ml volume of iron solution at 20 mg/L of concentration at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	20.02	19.97	2.70	90	0.030
	19.96				
	19.93				
30	3.45	3.44	2.70	90	0.030
	3.44				
	3.44				
60	1.23	1.24	2.70	90	0.030
	1.25				
	1.23				
90	0.24	0.24	2.70	90	0.030
	0.23				
	0.24				
120	0.12	0.13	2.70	90	0.030
	0.14				
	0.12				
150	0.05	0.04	2.70	90	0.030
	0.05				
	0.03				
180	0.00	0.00	2.70	90	0.030
	0.00				
	0.00				
210	0.00	0.00	2.70	90	0.030
	0.00				
	0.00				
240	0.00	0.00	2.70	90	0.030
	0.00				
	0.00				
270	0.00	0.00	2.70	90	0.030
	0.00				
	0.00				
300	0.00	0.00	2.70	90	0.030
	0.00				
	0.00				

Table D-36: Effect 800 ml volume of iron solution at 20 mg/L of concentration at 20 volts

Time	Conc.	Ave. Conc.	Current	Surface area (cm^2)	Current Density A/cm^2
0	19.96	19.96	2.76	90	0.031
	19.96				
	19.97				
30	6.70	6.71	2.76	90	0.031
	6.72				
	6.72				
60	1.12	1.14	2.76	90	0.031
	1.14				
	1.16				
90	0.56	0.56	2.76	90	0.031
	0.56				
	0.57				
120	0.22	0.21	2.76	90	0.031
	0.20				
	0.22				
150	0.05	0.04	2.76	90	0.031
	0.05				
	0.02				
180	0.00	0.00	2.76	90	0.031
	0.00				
	0.00				
210	0.00	0.00	2.76	90	0.031
	0.00				
	0.00				
240	0.00	0.00	2.76	90	0.031
	0.00				
	0.00				
270	0.00	0.00	2.76	90	0.031
	0.00				
	0.00				
300	0.00	0.00	2.76	90	0.031
	0.00				
	0.00				